Advanced Computer Aided Design, PPU080

Extra Tasks for the Project Work for the Academic Year 2020/2021

Approve of the mandatory parts of the excavator and the geometry assurance task will result in grade 3.0 for the project. The project grade can be increased (up to 6.0) by performing extra tasks which have to be approved by the supervisor.

The extra tasks shall be done individually.

The approval should be made on a student computer (not a personal laptop).

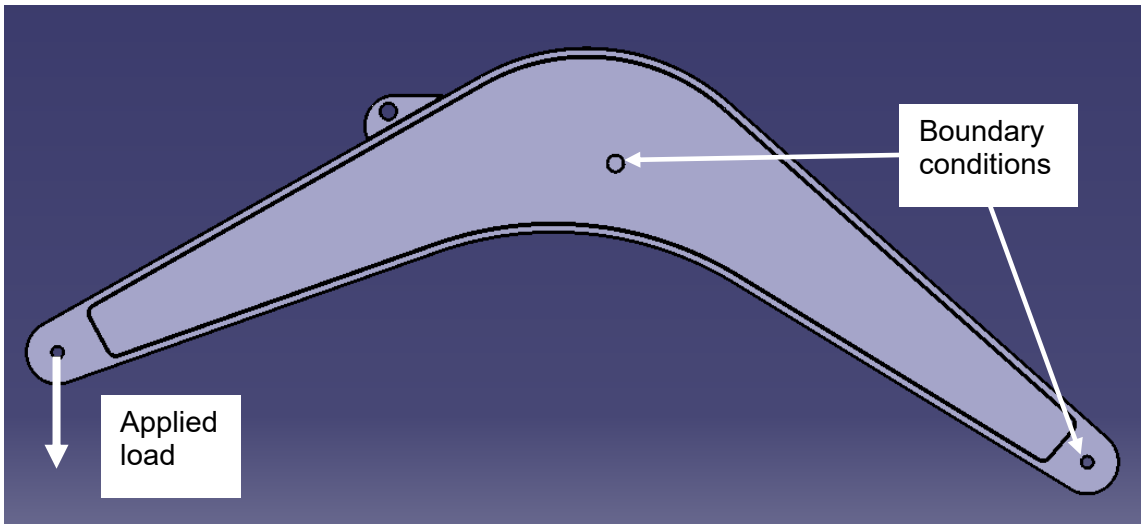
Note that one of the purposes of the extra tasks is that the student should train in using available information (e.g. Catia help) to learn how to use new functionality in a CAD-system. Therefore, less help than for the mandatory tasks can be expected from the teachers.

The extra tasks should be made in Catia or RD&T.

Each of the following nine tasks adds the indicated points to the project grade if they fulfill the requirements.

FE-analysis, 0.2 points

Analysis of the stresses in the boom.



- With realistic load and boundary conditions, don´t use clamp.
- Determine max von Mises stress, compare with yield stress.
- Determine an approximate break load.
- What are the sensitive areas?
- Plot von Mises stress
- Plot displacement
- Generate a simulation report.
- Comment on the result, are they realistic, could it be improved?

Use of Knowledgeware, 0.3 points

The task is to design and parameterize the boom in such a way that it automatically adjusts its length in relation to other characteristics of the excavator. An example is to relate the length, "BoomLength", to the length of the arm, "ArmLength" (the longer the arm, the shorter the boom so that the excavator always is in balance). (See Parametric_design_exercise.pdf for some help.)

- The adjustment should be stepwise so that the length of the boom is constant for a certain interval of arm length.
- There should be 5 arm length intervals.
- The solution has to be made so that there is only one part file using rules and relations to perform the necessary boom redesign.
- The solution should be implemented in the complete assembly.
- Rename parameters

Realistic Rendering, 0.2 points

A realistic rendering of the excavator including

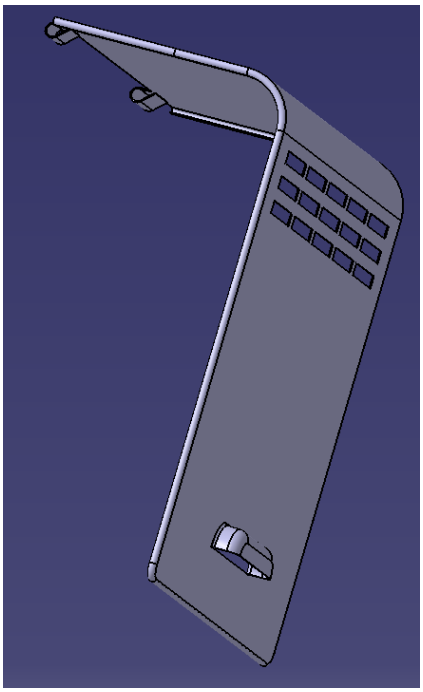
- a realistic environment,
- light sources,
- shadows (on both the excavator and on the ground),
- reflections and
- material.
- It should be standing on the ground
- It should be oriented correctly
- The shadows of the excavator should match the shadows in the background (sharpness etc.)

Animation, 0.4 points

Animation of a digging motion. All joints between boom, arm, and bucket should be active as well as the joint between the counterweight body and the undercarriage. The hydraulic cylinders can be omitted.

- All joints should be moving simultaneously at some point.
- The animation should be smooth.

Sheet Metal Design, 0.3 points

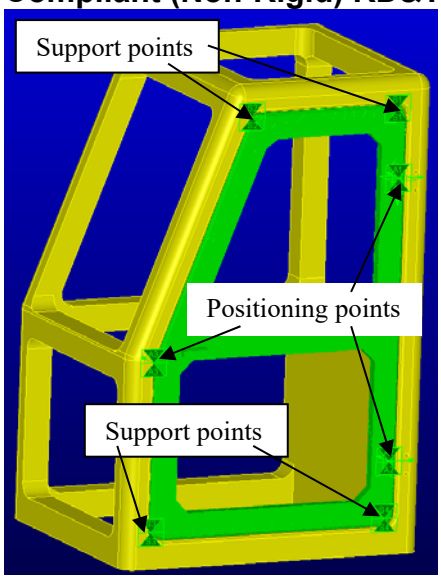


The Sheet Metal Design module makes it possible to design sheet metal parts while continuously switching between unfolded and folded part representation. The task is to design a hood (lid) on the counterweight body.

- The lid should be hinged and equipped with a handle.
- Hems should be used to provide structural support and smooth edges.
- Hemmed corners should be smooth.
- The hinged edge should not be hemmed.
- A grill (ventilation holes) should also be a part of the structure.
- Switching between unfolded and folded part representation should be possible.
- The handle should be made as a “louver”
- Switching between unfolded and folded part representation should be possible.
- It should be made of one piece of sheet metal.
- Consider the manufacturing sequence.
- Be prepared to discuss the model att the approval.

Using the Generative Sheet Metal Design workbench is recommended, but importing a part from other workbenches is also allowed. However, it is important that the structure is made in one piece, so that switching between unfolded and folded part representation is possible.
The lid does NOT have to be assembled on the excavator

Compliant (Non-Rigid) RD&T Analysis, 0.5 points



An ordinary RD&T model treats all parts as rigid parts that can only be constrained in six degrees of freedom. By using FE-meshes to model the parts also over-constrained positioning system can be used and the parts can be deformed.

Some extra supports are added in order to keep the relatively flexible door in flush with the cab, see the figure. The door should still be positioned by the hinges and the lock

Create a new RD&T model of the cab and the door. Create a FE-mesh of the door in Catia and use that in the RD&T model. In this case, the hinges can be omitted. Add tolerances to all positioning and support points. Create and analyze a number of flush measures between the door and the cab. Make the door rigid and compare the results.

See Exercise_Compliant for information on how to create a non-rigid model in RD&T.

- Present the variation results for the flush measures for both the rigid and non-rigid case.
- Do a “Part Variation Color” analysis for both the rigid and non-rigid case.
- What is the difference in variation between rigid and non-rigid?

Ergonomic Analysis (Manikin and Interior), 0.4 points

The interior of the excavator is to be designed in this task. The interior should contain a chair, footrest, 2 levers to control the boom, the arm and the bucket and a wheel or joysticks to be able to steer the excavator. To make sure the interior of the cabin is appropriate for humans, manikins will be seated in the excavator.

The cabin should be suitable for a 5 percentile of the female and 95 percentile of the male population of interest (i.e. the market you are focusing on) i.e. a small woman and a large man.

- Both manikins must be able to reach all the controls while seated in the cabin.

The working position, hands, legs,… should be comfortable, i.e.

- The feet should be resting on the floor.
- The back should be in contact with the backrest.
- What adjustments are needed?
- Any adjustments of the seat etc should be parameterized with one parameter. “Memory seat”
- Visibility envelope, is it OK, how could it be improved?

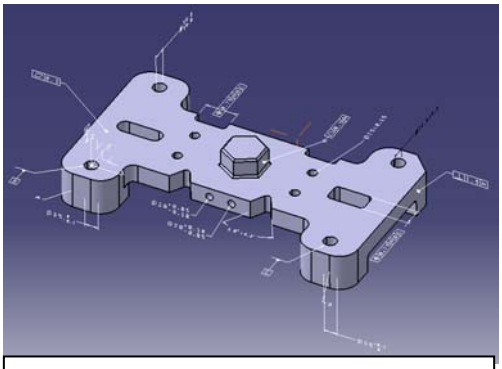
The purpose of this task is to learn how to use the manikin so the geometry of the interior can be rater simple.

3D PMI (Product and Manufacturing Information) 0.3 points

As of today, the product and manufacturing requirements are conveyed with the help of 2D drawings. In this era of digitization, 3D models are seen as replacement for 2D drawings as the master for product technical data in manufacturing industry.

Many companies today strive for replacing 2D drawings with 3D PMI

The task is to create 3D PMI for one of your hinges.



http://dx.doi.org/10.6028/NIST.GCR.15-997

It should include:

- Datum Targets for the positioning system
- Be completely dimensioned
- Have specified GD&T tolerances on holes.
- Have specified GD&T tolerances on **functional surfaces**.
- Make a reasonable estimate of the numbers for the tolerances.
- Use at least 3 “Views” to place the PMIs, e.g. according to the main coordinate planes.

Use the workbench “Product Functional Tolerancing & Annotation” in Catia.

Machining 0.4 points

The task is to plan the machining of a plate that should be mounted on the excavator. The raw material (called Rough Stock) and the shape of the plate (as a PartBody) is available in the file Plate_template.CATPart, downloadable from Canvas.

- The plate should state your name. If you like, you can also add a logo.
- Use the workbench Prismatic Machining.
- Use a 3-axis NC machine.
- You can either sketch the letters yourself or follow the instructions in Letters.pdf which can be downloaded from Canvas.
- The top surface of the plate and letters should be finished to have a fairly smooth surface.
- Also the edges of the letters should be finished.
- There should be two drilled holes that could be used to assemble the plate to the excavator.
- At least three different tools should be used.
- The back and edges of the plate does not need to be machined.
- For the approval of the task you shall show an animation of the machining, like in the picture below.
- Be prepared to discuss your model at the approval.